Brief

Research Investigation RI 02-033
Research Report RDT 04-010

June, 2004

Evaluation of Bridge Approach Slabs, Performance and Design

The existing design for Bridge Approach Slab (BAS) was last modified in the early 1990s. However, this bridge component has been reported to be performing below expectations. This problem is prevalent throughout the Midwest and a solution has not been reached at a regional level. The design changes in the early 1990's resulted in approach slabs of about 8m in length supported at one end on the bridge abutment (often pile supported) and at the other by a sleeper beam resting on the embankment. Some of these slabs have experienced excessive deformation of the foundation and fill soils under the slab and sleeper beam. Survey questionnaires were administered to resident engineers in MoDOT and DOT's in neighboring states to assess overall BAS performance.

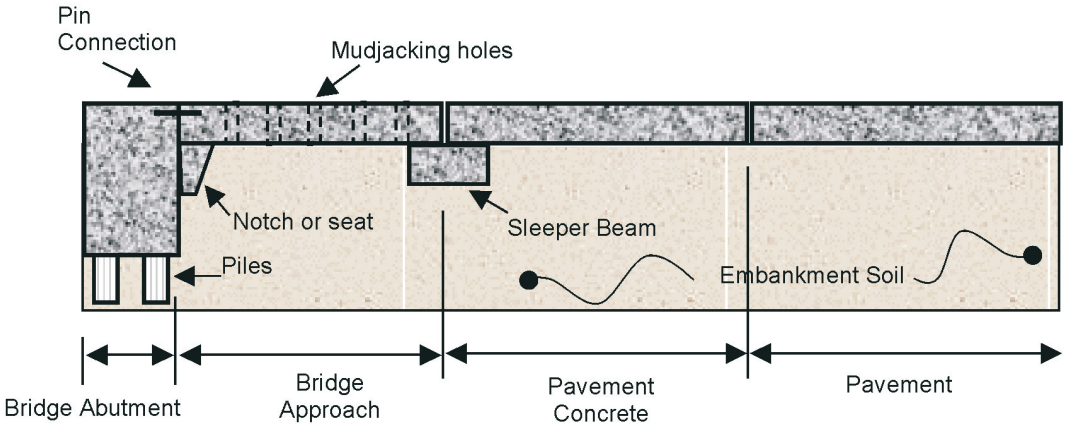

Figure 1 - MoDOT Post-1993 Bridge Approach Design, after Bowders, et al. (2002)

Two bridge sites utilizing the existing design were selected to investigate the deformation mechanisms. Detailed subsurface characterization of existing bridge embankments utilizing the new design were carried out. The characterization efforts consisted of drilling and sampling of boreholes, laboratory testing and cone penetrometer tests at each site. Analyses involving modeling using a finite element method program were conducted using soil properties obtained from the site characterization programs.

Both hand calculations and finite element analysis were carried out for these bridge sites. The Livingston County bridge site was selected due to its compressible foundation, which resulted in variable material properties, requiring calculated deformations to be reported as a range. The computed vertical deformations for the embankment ranged from 0.3 to 0.6 m for the site in Livingston County. However, only the deformations that occurred after the construction of the slab are structurally important. The Crawford County bridge site has a more firm foundation with shallow rock. Soil samples were difficult to obtain due to hard ground conditions, so material properties were estimated based on index properties. For the Crawford County bridge

Research Development and Technology

Missouri Department of Transportation

1617 Missouri Blvd.
P.O. Box 270
Jefferson City,
Missouri 65101

site the settlement was much less in the order of about 0.08 m. The actual deformation from the end of construction to the current conditions has not been measured with time; therefore, no comparisons can be made between predicted and measured data. One of the salient recommendations to MoDOT is to start a programmatic approach to instrument and monitor deformations of select earth structures to be able to calibrate and compare with analytical techniques (i.e., settlement calculations, finite element method, etc.)

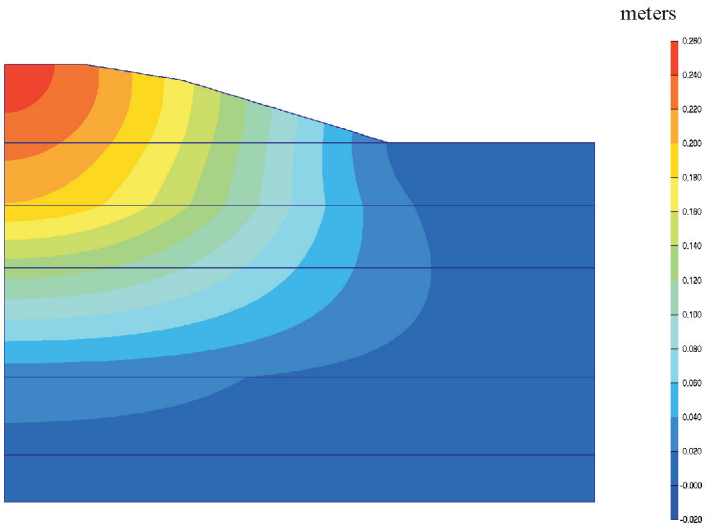

Figure 2 - Bridge approach embankment on Rt. 19 in Crawford County and results of the finite element analysis showing displacement cotours in meters.

After evaluating the different solutions available and given the design and construction practice at MoDOT, it is recommended that means to stiffen the embankment be investigated. This will make the transition to the very unyielding bridge less abrupt and reduce the compressibility of the embankment fill. A reinforced soil embankment is proposed as a solution for the embankments that are of significant height. This reinforcement should be extended from the abutment a significant distance into the embankment. Compressibility of the foundation soils should be evaluated on a case-by-case basis based on additional boreholes completed before design behind the bridge abutment.

Conclusions and recommendations presented in the report are in the following categories: initiating programmatic instrumentation and monitoring plans for approach embankments; enhanced drilling, sampling and analysis at locations of future embankments; geosynthetic reinforcement of the embankment; staged construction; separating grading and paving contract; abutment and drainage details; and improved compaction specifications. An implementation plan and milestones are also presented in this report.

For more information contact:

Ronaldo Luna, PhD, PE
Associate Professor
Department of Civil, Arch. & Env. Engineering
University of Missouri-Rolla
130 Butler-Carlton Hall
Rolla, MO 65409
+(573)341-4484
(573)341-4729
http://web.umr.edu/geotech
http://web.umr.edu/civil

Tom Fennessey
Senior Materials Engineer
Missouri Department of Transportation
P.O. Box 270
Jefferson City, MO 65102
Tel: 573-526-4340
Tom.Fennessey@modot.mo.gov

Missouri Department of Transportation
Research, Development and Technology
1617 Missouri Blvd.
P.O. Box 270
Jefferson City, MO 65102

Phone: (573) 751-3002
1-888-ASK MODOT
Email: rdtcomments@modot.mo.gov
Web Address: www.modot.org/services/rdt